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# Volcanic stratigraphy and mineral potential of the Aylmer dome, southeastern Slave Province, Northwest Territories[1]

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**Abstract:** The Aylmer dome is a prominent geological feature in the northeastern Walmsley Lake map sheet (NTS 75 N), southeastern Slave Province. The dome is composed of a granitoid core rimmed by a narrow volcanic belt, overlain by regionally extensive metaturbidite of the Yellowknife Supergroup. The volcanic stratigraphy comprises a conformable succession of basal mafic flows and gabbroic sills, overlain by a fine-grained, intermediate to felsic volcaniclastic sequence with a lens of intermediate breccia in the northwest. The upper felsic sequence is capped by iron-formation deposited at the volcanic–sedimentary interface.

Airborne magnetic and electromagnetic geophysical surveys defined several conductive and magnetic horizons within the volcanic belt, and a continuous magnetic and conductive response coincident with the capping iron-formation. Ongoing work is aimed at resolution of a more detailed stratigraphy and petrogenesis of the volcanic rocks and will aid in assessing the mineral potential of the belt, in particular the magnetic and conductive horizons identified by geophysics.

**Résumé :** Le dôme d'Aylmer est une structure géologique saillante sur la coupure de la partie nord-est du lac Walmsley (SNRC 75 N), dans le sud-est de la Province des Esclaves. Il est formé d'un noyau granitoïde bordé d'une ceinture volcanique étroite, que recouvre une métaturbidite du Supergroupe de Yellowknife très étendue à l'échelle régionale. La stratigraphie volcanique comprend une succession concordante de coulées mafiques de base et de filons-couches gabbroïques que recouvre une séquence volcanoclastique à grain fin de composition intermédiaire à felsique accompagnée d'une lentille de brèche intermédiaire dans le nord-ouest. La partie supérieure de la séquence felsique est coiffée d'une formation de fer déposée à l'interface volcano-sédimentaire.

Les levés géophysiques magnétiques et électromagnétiques aériens ont permis de définir plusieurs horizons conducteurs et magnétiques dans la ceinture volcanique et une réponse magnétique et conductrice continue qui coïncide avec la formation de fer de recouvrement. Les travaux en cours visent à obtenir des données stratigraphiques et pétrogenétiques plus détaillées sur les roches volcaniques et permettra d'évaluer le potentiel minéral de la ceinture, en particulier celui des horizons magnétiques et conducteurs mis en évidence par les levés géophysiques.

[1] A contribution to the Walmsley Lake TGI Project (#000013)

## INTRODUCTION AND PREVIOUS WORK

This study is part of a multidisciplinary geological project that commenced in 2000 in the Walmsley Lake area, southeastern Slave Province (*see* MacLachlan et al., in press). The Walmsley Lake Project is jointly funded and undertaken by the C.S. Lord Northern Geoscience Centre in Yellowknife and the Geological Survey of Canada, under the Targeted Geoscience Initiative. The specific work reported here on the Aylmer dome represents the field component of an M.Sc. thesis project at the University of Western Ontario and is supported by the C.S. Lord Northern Geoscience Centre and Navigator Exploration Corporation.

The Aylmer dome is situated in the northeastern corner of the Walmsley Lake map area, 350 km northeast of Yellowknife (Fig. 1). It occurs about 80 km north of the treeline within low-lying barrenlands characterized by glacial outwash, muskeg, and numerous lakes. Outcrop is sparse especially on the eastern and southern margins of the dome.

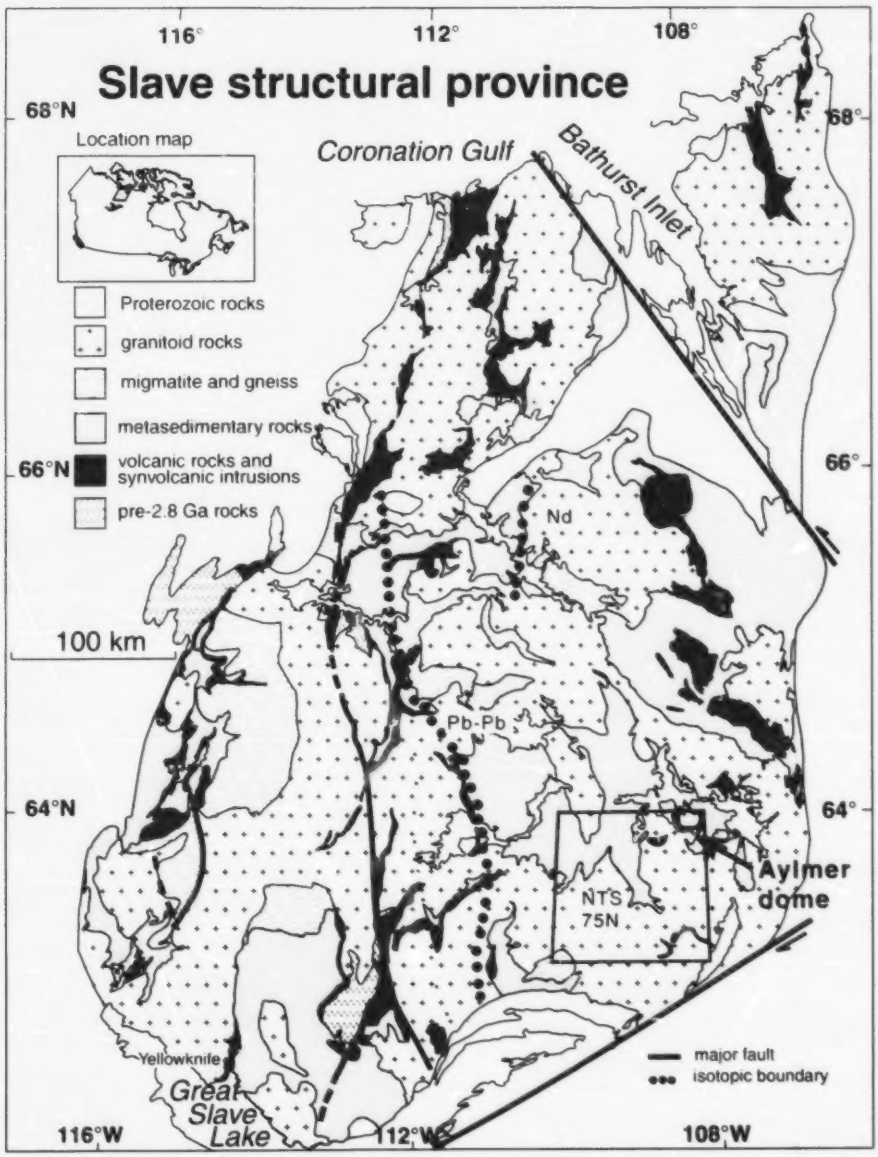


***Figure 1.*** *Simplified geological map of the Slave Province showing the location of the Walmsley Lake map area (modified from Gill and Robertson, 1979).*

The results reported here are based on three weeks of field mapping at 1:30 000 scale to better resolve the volcanic stratigraphy and document contact relationships between the volcanic belt and adjacent granitoid and metasedimentary rocks. Samples were collected for analysis to determine the geochemical characteristics of the rocks and their possible tectonic setting. Better resolution of the volcanic stratigraphy utilizing available high-resolution geophysical data will allow more critical assessment of the economic potential of the volcanic belt for hosting volcanic massive-sulphide and/or lode-gold mineralization. Particular attention will be paid to the volcanic-sedimentary interface, which is interpreted here (*see* below) as an Algoma-type iron-formation, and may have potential to host lode gold.

The Walmsley Lake (NTS 75 N/11-14) and Aylmer Lake (NTS 75 N/16) map sheets were first mapped at a reconnaissance scale of 1:256 720 by Folinsbee (1950). This mapping defined a domal structure with a granitoid core rimmed by an undifferentiated volcanic belt and overlain by voluminous metasedimentary rocks. Gossanous zones on the western segment of the Aylmer dome were first staked by an undocumented company in 1961 and these claims lapsed in 1962. In 1975, the northwestern part of the belt was staked by Great Plains Development Corporation and these claims lapsed in 1976. The area was remapped and the volcanic-sedimentary contact staked and explored by Getty Canadian Metals Limited from 1977 to 1979. The target was volcanogenic massive sulphides at the top of the volcanic pile (Gill and Robertson, 1979). Ground geophysical and geochemical surveys were carried out at that time. In 1979, Getty Canadian Metals Limited drilled a conductive horizon at the volcanic-sediment contact that proved to be a pyritiferous graphite unit. Following the discovery of diamond-bearing kimberlite in the Lac de Gras area, the entire Aylmer dome was staked for kimberlite exploration in the early 1990s. In 1992, Tyler Resources acquired the claims and carried out detailed airborne and ground geophysical surveys, till sampling, and drilling (D.L. McConnell, unpub. report, 1993). The claims are currently held by Navigator Exploration Corporation who is reassessing its potential for diamondiferous kimberlite, volcanic massive sulphide, and lode gold mineralization (K. Armstrong and R. Hopkins, unpub. report, 1999).

## TECTONOSTRATIGRAPHY OF THE AYLMER DOME

The Aylmer dome comprises a granitic core 15 km in diameter, structurally overlain by a greenstone belt roughly 3 km wide in map view (Fig. 2). Multiply deformed biotite-cordierite-garnet-grade metaturbidite stratigraphically overlies the volcanic belt. The stratigraphic sequence, combined with rare facing directions in pillowed flows, indicate younging away from the core. On the southeast margin of the dome, the volcanic stratigraphy is cut by two granitoid bodies.

Rocks of the volcanic portion of the Aylmer dome are best exposed on the northern and western segments; the southern and eastern segments are heavily till covered. The volcanic stratigraphy consists of basal mafic flows and associated gabbroic sills, and an upper intermediate to felsic succession interpreted to be predominantly metamorphosed tuff. The felsic rocks are capped by iron-formation, which is in turn overlain by metaturbidite typical of the Yellowknife Supergroup. Individual map units and their contact relations are described in the following sections. Geochemically based rock names are used as field terms and remain to be substantiated by petrographic and geochemical studies. A simplified geological map of the area is presented in Figure 2.

### *Granitoid core*

In the core of the Aylmer dome three plugs of massive monzogranite (undifferentiated in Figure 2) cut foliated biotite-hornblende granodiorite. The plugs are characterized by high magnetic signatures (K. Armstrong and R. Hopkins, unpub. report, 1999), and their contacts can be easily projected through areas of poor outcrop. Granodiorite constitutes the margin of the core and contains a shallowly (15°–30°) outward-dipping foliation defined by biotite and hornblende. The granodiorite is progressively more deformed toward the contact with the volcanic belt and is locally protomylonitic. A layer of amphibolitic gneiss (Fig. 3A) 100 m thick mantles the foliated granodiorite and forms the base of the volcanic belt. The foliation in the amphibolite dips 50° to 80° outward from the centre of the dome and is defined by fine compositional

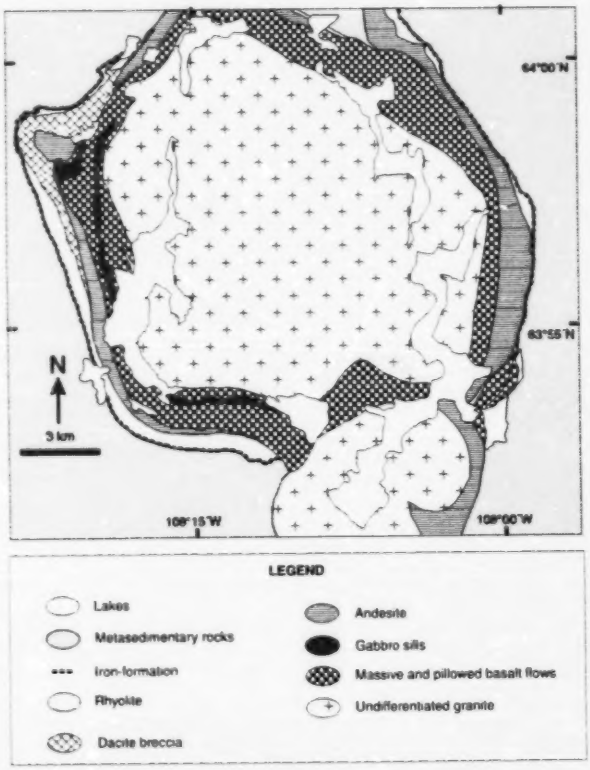


***Figure 2.*** *Simplified geological map of the Aylmer dome.*

banding of hornblende- and plagioclase-rich layers (Fig. 3B). A strain gradient can be traced discontinuously from well preserved pillows into the amphibolitic gneiss, where the fine banding is interpreted to be a recrystallized mylonitic fabric. Despite this evidence for strain, no extension-lineation or shear-sense indicators were recognized. The mineral assemblage in the amphibolite gneiss is similar to that in the overlying basalt, which is interpreted as the protolith for the amphibolite gneiss. The contact between the amphibolite and the underlying granodiorite parallels the foliation in both units, making relative ages impossible to determine. A strongly foliated, weakly chloritized phase of the granodiorite about 30 m from the base of the amphibolite was sampled for U-Pb dating.

### *Basal mafic flows and sills*

The base of the volcanic sequence consists of mafic volcanic rocks that immediately overlie the banded amphibolite gneiss. The contact between the basal mafic flows and the underlying mafic gneiss was not observed in outcrop, although locally it could be mapped to within a few metres. Mafic flows make up the largest portion of the volcanic belt, comprising a unit from 0.5 to 1 km in (apparent) thickness. The lower part of the section consists predominately of pillowed flows, giving way upsection to massive flows. The pillows are extremely fine grained and typically black, suggesting the presence of hornblende (Fig. 3C). The pillows have thin (2–3 cm) selvages, locally contain quartz-filled amygdules, and have been variably flattened parallel to bedding, with aspect ratios ranging from 10:1 to 20:1. Although

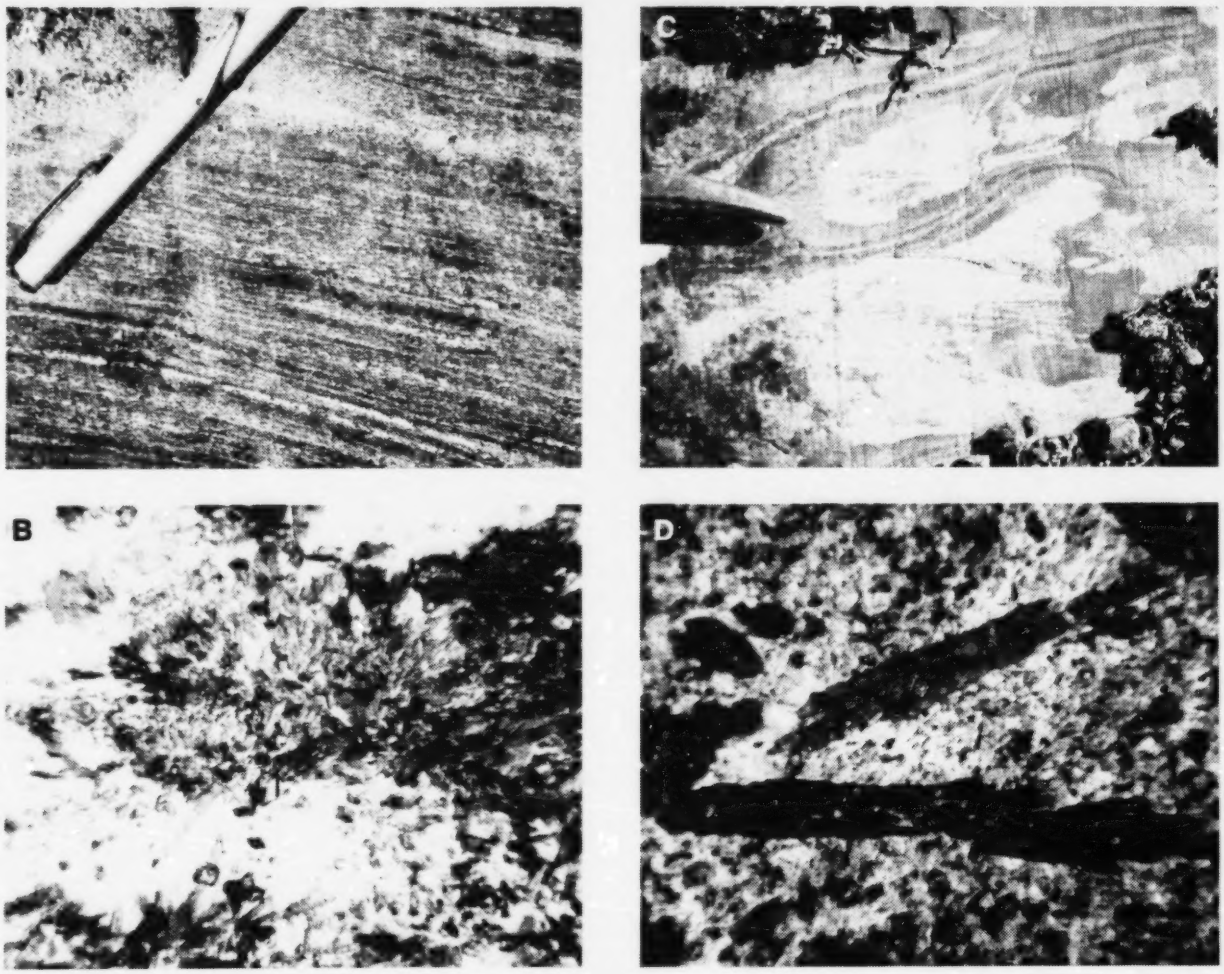


***Figure 3. A)** Banded amphibolite gneiss at the contact between overlying volcanic rocks and granitoid rocks in the core of the Aylmer dome; **B)** photomicrograph of banded amphibolite showing banding of amphibole-poor and amphibole-rich layers (40x magnification); **C)** pillowed mafic volcanic rock with well preserved selvages; **D)** photomicrograph of andesite showing coarser grained amphibole in a finer grained quartzofeldspathic groundmass (40x magnification).*

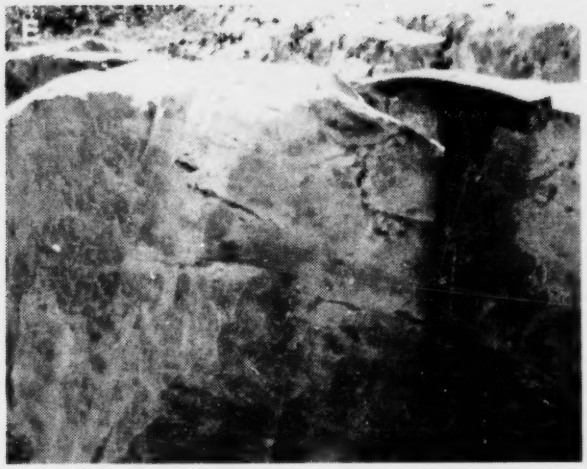

***Figure 3.*** *E) thinly banded rhyolite tuff (west central Aylmer dome); F) gossanous weathering of silicate-sulphide facies iron-formation; G) photomicrograph of silicate iron-formation showing abundant white amphibole (grunerite) and minor pyrite (40x magnification).*

rarely preserved, flow-top directions in pillows young consistently outward from the core of the dome. The upper 600 m of the mafic part of the volcanic section lack well preserved pillows, and massive units are locally well foliated and exhibit millimetre-scale banding, roughly parallel to bedding. The origin of this banding is unclear and could be either primary or metamorphic.

Gabbro sills intrude the mafic flows in the northwestern and southern segments of the volcanic belt. They are up to 200 m thick and single sills can be traced for up to 5 km along strike. The sills have fine-grained, black margins that grade into coarse-grained centres with radiating hornblende up to 2 cm long. Sills have not yet been recognized in the poorly exposed northern and eastern segments of the dome.

### *Upper intermediate to felsic volcaniclastic rocks*

Immediately overlying the uppermost mafic flows is a succession of fine-grained volcaniclastic rocks, possibly of tuffaceous origin, with bulk compositions varying from intermediate at the base to felsic at the top. Geochemical data do not yet exist to support the assignment of compositional names to these units; however, these are sufficiently distinct in terms of colour and hardness to recognize three map units. The field terms andesite, dacite, and rhyolite are used in the following section to represent the most mafic, intermediate, and most felsic units, respectively (Fig. 2).

#### Andesite

A thinly bedded unit (1–2 cm) of fine-grained, pale green to grey, leucocratic, plagioclase- and hornblende-bearing rocks overlies the uppermost mafic flows described above (Fig. 3D). This unit has a moderate foliation parallel to bedding and can be mapped continuously around the entire dome. It varies from 50 to 100 m thick on the western side to 100 to 300 m thick (apparent thickness) on the eastern side of the dome (Fig. 2). Some beds contain fine-grained, euhedral plagioclase crystals indicating minimal reworking during deposition. Examination of thin sections reveals a lack of rounded grains consistent with the interpretation of these rocks as tuff or minimally reworked volcaniclastic rocks.

#### Dacite

On the western side of the dome, a light green banded unit with a weak bedding-parallel foliation overlies the andesite described above (Fig. 2). It occurs only on the western side of the dome and ranges in apparent thickness from 50 to 200 m. The rocks are too fine grained to identify constituent minerals, but on the basis of colour and hardness, they are estimated to have a dacitic bulk composition. They are thinly banded (1–2 cm) and contain rare quartz eyes up to 2 mm in diameter. Near the upper contact of the unit, thin (5–10 cm) beds of garnet- and hornblende-bearing rocks are interlayered with the light green bands. The origin of these mafic layers is unknown, but they are tentatively identified as metamorphosed ferruginous mudstone deposited during periods of volcanic quiescence. On the northwestern corner of the dome,

a dacitic breccia containing angular clasts averaging about 20 cm in diameter is tentatively interpreted as a flow breccia on the basis of the interlocking configuration of its clasts. Elsewhere, units of coarse, mixed mafic–felsic fragmentals with 4 to 5 cm angular to rounded clasts are locally interstratified within the uppermost dacitic units, and are tentatively interpreted as debris flows.

### Rhyolite

The uppermost unit of the volcanic belt is very siliceous and best exposed on the western margin, where its apparent thickness ranges from 50 to 200 m (Fig. 2). It is thinly (1–2 cm) banded, weakly foliated parallel to bedding, light grey to pale white, fine grained, and extremely hard, suggesting a felsic bulk composition (Fig. 3E). Quartz eyes (1–2 mm) were observed in some bands, but are uncommon. The uppermost part of this unit is marked by recessively weathering carbonate±quartz-rich units, and rare interbedded pelite. The origin of the carbonate is unclear, but further examination of this unit in the field and in thin section will address this question.

### Iron-formation

The uppermost felsic rocks of the volcanic belt are capped by a sulphide-rich (pyrrhotite>pyrite) unit (Fig. 3F) about 50 m thick, that has been mapped discontinuously around the entire dome. Where the unit is not exposed, it can be traced by a gossanous bolder train, and its continuity is demonstrated by its high positive total-field magnetic signature (K. Armstrong and R. Hopkins, unpub. report, 1999). The unit is a coarsely banded two-amphibole (white grunerite–cummingtonite and green hornblende, Fig. 3G), quartz-rich rock, interlayered with thin bands rich in pyrrhotite and pyrite. Biotite-rich pelite, locally pyrrhotite-bearing, are interlayered with the upper part of the unit, suggesting a conformable contact with the overlying metaturbidite. On the basis of its iron-rich composition, the unit is interpreted as a silicate-facies iron-formation.

The thinly bedded, siliceous nature of this iron-formation and its association with volcanic rocks suggest a similarity to Algoma-type iron-formation. Mapping to date in the area has failed to identify any iron-formation elsewhere in the metaturbidite, suggesting that the relationship to volcanic rocks may be significant and further supporting the Algoma-type model. A petrogenetic study of the volcanic rocks is underway to further assess this model (Algoma-type iron-formation is typically associated with arc volcanic rocks). Iron-formation can act as excellent structural and chemical sites for gold mineralization (e.g. the Lupin mine near Contwoyto Lake and the Meadowbank deposit in the Western Churchill Province); the mineral potential of this iron-formation is virtually untested.

### Metaturbidite

The Aylmer dome is conformably overlain by biotite±cordierite±garnet-bearing metaturbidite that records evidence of polyphase deformation. These rocks were not mapped in detail during this study, although they will be mapped in subsequent years as part of the Walmsley Lake Project. MacLachlan et al. (in press) describe metaturbidite in the Back Lake area 53 km to the west, and on the basis of observations made to date in the Aylmer Lake area, their descriptions apply equally well to the map area in this study.

## URANIUM-LEAD DATING AND TRACER-ISOTOPE STUDIES

Several samples were collected from the Aylmer dome for U-Pb dating. A foliated biotite granite that crosscuts the volcanic stratigraphy and bedding-parallel foliation on the southeast margin of the dome, and a massive plagioclase-porphyritic felsic dyke that cuts foliated mafic volcanic rocks will help constrain the time of deformation and metamorphism in this area. A felsic tuff from the uppermost part of the volcanic sequence was sampled to date volcanism. The foliated granodiorite from the core of the dome was also sampled to determine its age relative to the volcanic pile, and to provide a minimum age for deformation along the granite core–volcanic interface. The above samples, as well as mafic volcanic rocks, will be analyzed for Sm-Nd isotopic composition as part of the regional study of sources for magmatic rocks (*see* MacLachlan et al., in press). Analyses of the volcanic rocks, which are expected to be juvenile (cf. Thorpe et al., 1992) will provide an estimate of the isotopic composition of late Archean mantle in the area.

## CONCLUSIONS

The Aylmer dome is an upward-facing structure with a core of mixed granitoid rocks separated from the overlying volcanic belt by a poorly understood high-strain zone. Further work on the granite–volcanic contact is needed to determine the significance of the high-strain zone. The volcanic succession is conformable with basal mafic (basaltic) flows and synvolcanic sills overlain by intermediate to felsic tuffaceous rocks. Detailed petrographic studies are underway to support the field interpretations reported herein. Bulk-rock and trace-element geochemical analyses will be undertaken to help reconstruct the tectonic setting. An important question is whether the dome consists of two geochemically distinct volcanic sequences, i.e. a tholeiitic lower sequence and upper calc-alkalic succession, or whether it is a single, differentiated calc-alkalic package.

An interesting feature of the Aylmer dome is that the volcanic rocks show only limited evidence for the polyphase deformation exhibited by conformably overlying metaturbidite. The age of the main bedding-parallel foliation in the volcanic rocks may be different from that of the main foliation elsewhere in the area. This question will be addressed by future mapping and U-/Pb dating outlined above.

Future geological mapping will benefit from high-resolution airborne geophysical data supplied by Navigator Exploration Corporation (K. Armstrong and R. Hopkins,

unpub. report, 1999). Because of the most recent exploration aimed at kimberlite discoveries, the Aylmer Lake volcanic belt has excellent detailed geophysical coverage. Poor exposure in the eastern part of the dome makes it difficult to trace volcanic units. The geophysical data will be used as a mapping tool to extrapolate the stratigraphy. Thin magnetic units occur throughout the upper felsic part of the package, and a highly magnetic unit defines the volcanic–sedimentary interface. The correspondence between peripheral iron-formation and the magnetic data delineates a more or less continuously magnetic and/or conductive horizon over the entire 60 km of the volcanic–sedimentary interface. Future work will critically assess the metallogenic significance of the magnetic and/or conductive units delineated throughout the volcanic succession.

## ACKNOWLEDGMENTS

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